AN ABERRANT LIMB IN A CRAY-FISH.

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A striking aberration in the form of a third, left-walking leg of a female *Cambarus Bartoni* found in class dissection in February, 1892, seems of enough interest to warrant its being put on record.

A view of the anterior face of the limb (Fig. 1) shows a markedly forceps-like structure in addition to the usual forceps at the end of the limb, so that there are four instead of the usual two terminal points.

The added structure is, however, not a true forceps with one movable finger, but a movable piece with two immobile prongs

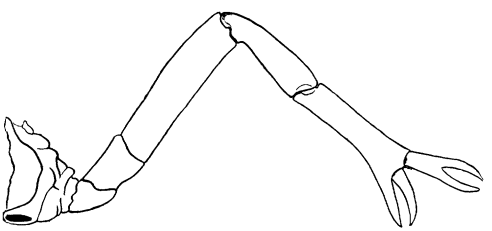

FIG. 1. Camera sketch of anterior face of left third leg of *C. Bartoni*. Genita opening indicated in black.

that otherwise resemble the index and pollex of a forceps. This is evident in the enlarged view, Fig. 2.

The real forceps in this limb is nearly normal, but on comparing it with an anterior view of the third walking leg of a normal *C. Bartoni* (Fig. 3), of about the same size, we may note some differences. Thus, in place of the straight-lined articulation of dactyl and propodite, we find the propodite presenting a hollowed, socket-like face where the dactyl articulates. Again, while the dactyl and the index are both normal in form, the dactyl is not a straight continuation of the propodite, but bends down at a noticeable angle, thus increasing the wide divergence of the double set of tips of this limb.

The propodite departs from the usual form in being wider distally where it bears, as it were, a large protuberance that is

truncated to articulate with the unusual pronged structure or second claw-like ending of the limb. There is also an abnormality in the propodite, indicated in Fig. 2, and suggesting some former injury; it is a slight indentation upon the middle of the anterior face.

The movements possible to the dactyl in the normal, alcoholic specimen (Fig. 3) are a swinging of 4.11 mm. in one plane to

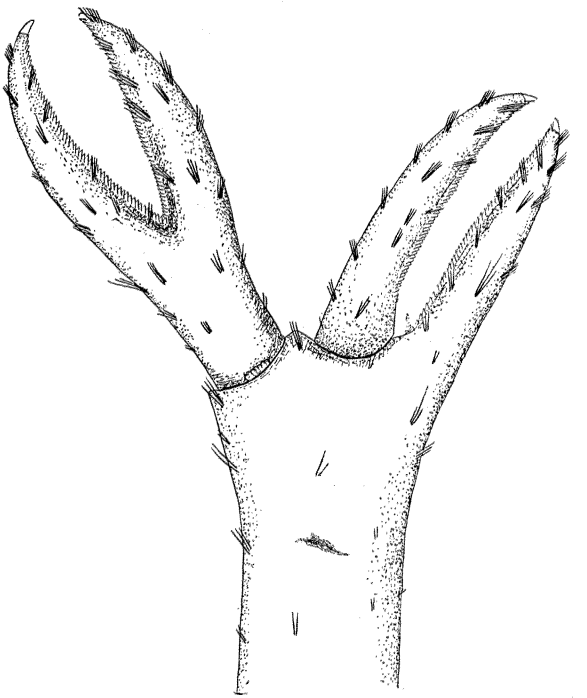

FIG. 2. Anterior view of terminal part of Fig. 1. Camera. Zeiss 2, a.

bring about direct apposition of the tips of the forceps, with no overlapping and also a very slight lateral movement.

In the aberrant limb the dactyl is so set that apposition is imperfect; the dactyl passes the tip of the index by about .5 mm. while the entire swing is the same as above, 4.11 mm. The actual gape of the forceps is restricted to that same amount, .5 mm. All movement in this forceps is strictly in one plane.

Next considering the monstrous, pronged structure we find that, starting from the position shown in Fig. 2, there is a possible

movement of 2.5 mm. in the plane of the real forceps, one half of this being towards the forceps and one half away from it. There is also mobility at right angles to the above plane, in a general antero-posterior direction. Anteriorly this is 1.5 mm. and posteriorly about .7 mm., a total swing of 2.2 mm. On moving the abnormal structure and the normal dactyl as far as possible toward one another they came just into contact. The angle of divergence between the index and the most remote part of the abnormal structure is greater than the extreme opening of a normal claw.

The form of the pronged structure is remarkable for its symmetry: the two prongs (Fig. 2) differ but slightly in shape and in size. But the one standing nearer to the claw is slightly

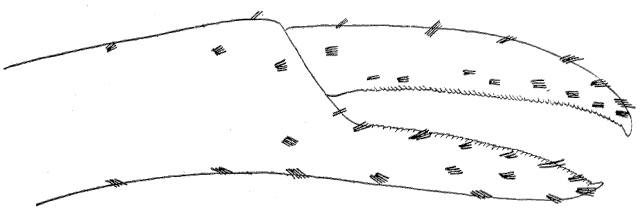

FIG. 3. Camera sketch of an anterior view of a terminal part of the third left leg of a normal *C. Bartoni.*

thicker and less sharply pointed and it also lacks the clear, perforated horn-like tip present upon the other prongs as upon normal claws. That this tip was lost by wear or by accident seems evident from the rough surface ending the prong and from the fact that staining liquids easily enter at this point.

Since the anterior and posterior faces of the prongs are not alike one could not put either prong into a space of the shape of the other prong; the two prongs are symmetrical about a plane between them; they are mirror images of one another, except for the above noted difference in form. This symmetry extends to such details as the distribution of clusters of bristles or hairs and to the arrangement and number of the serrations along the opposed faces of the prongs.

This latter detail deserves special description. These serrations are like those along the opposed faces of the dactyl and the index and they add greatly to the *impression that the pronged structure*

is in some sort an imitation claw. On both dactyl and index is a long series of transverse plates closely crowded together and freely projecting to give the serrated appearance noticeable under a low power. Each plate is itself serrated near its tip but these fine serrations are seen only with a higher power. As these plates stand nearer to the posterior than to the anterior face of the claw, they are more readily seen from a posterior view. Each plate, like these in Fig. 4, stands obliquely transverse and is shaped like a scalene triangle with bluntly rounded apex. It is just below this apex that the outer and distal edge bears a series of sharp teeth. This fine serration is on the edge that faces posteriorly as well as distally and the plates overlap one another so that the teeth could not be seen from an anterior view, such as Fig. 2, were it not that the plates are so transparent that the teeth can be seen through the next overlapping plate. Each plate has a central canal that passes from the epidermis through the length of the plate and ends at the surface in the blunt apex: it passes by the serrations without any connection with them. Morphologically these plates seem to be flattened setæ or hairs. In this claw there are 61 plates on the dactyl and 67 on the index; three or four are broken. As seen in Fig. 2 the series of plates is longer on the index where the proximal six or seven plates are opposed by a bare space upon the dactyl. With this exception the plates of the index and dactyl correspond, each plate having its duplicate in the opposite series.

In the pronged structure there are two series of serrations showing this same symmetry; some of each series are represented in Fig. 4.

To save space the two series are drawn as if close together while in reality the rigid prongs always held the two series far apart (Fig. 2). The plate marked T is about the thirty-fifth one from the tip of the prong that has a perfect terminal spine. The edges with teeth are those nearer to the tip and also those farthest away from the serrations of the opposite series.[1] The edge turned toward the plate of the opposite series is smooth and free. The third edge of the triangular plate is the line of attachment and is

[1] The use of these serrated plates may be to aid in cleaning the animal rather than to aid in preparing food by acting against the opposed series; they may be like the combs on the legs of certain birds.

somewhat anterior to the free tip of the plate. The terminal plates are smaller than the others and have a smaller number of teeth. This number may be as high as twelve toward the middle of the series. In all these respects the plates of the monstrous growth agree with those of the real claw. No difference was found between single plates of the dactyl and the index, nor between plates of the two prongs nor between plates of the normal and abnormal growths.

The pronged structure, however, differs from the natural claw both in number of plates and in their arrangement at the angle. While the normal claw has 61 and 67 plates the pronged struc-

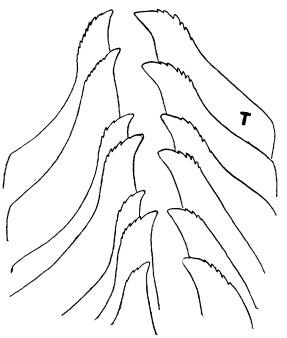

FIG. 4. Camera sketch of posterior view of serrated plates from the abnormal pronged structure. 2-D.

ture has 53 on the prong with a broken tip and 54 on the other. At the angle (Fig. 2) the plates have the arrangement shown in Fig. 5 : the terminal plates are crowded together and the two series interfere at the angle. Plate 52 of the imperfect prong steps out of rank and stands partly in between plates 53 and 54 of the series on the perfect prong, which is indicated by the letter T on the fifty-second plate. The angle thus has plates of both series carried into it till they fuse into one curved line. Moreover, these plates at the angle are not the same as the terminal plates of the normal claw, nor do they agree in number of teeth with plates at that distance from the tip of the normal claw. They are evidently special terminal plates in their own series but not directly comparable with the normal terminal plates. The prongs are shorter than the index and the dactyl and have not room for a full number of plates. Where they have a free edge

it is set with plates at the same rate as on an equal length of claw edge. If the common base of the prongs were to be split for about two fifths of its length and the prongs so lengthened they could bear about seventy plates each and the prongs would be much more like the normal claw; still it would be necessary to transform the present terminal plates at the angle into plates of the right character in the new series and to make new terminals at the new proximal ends.

But little was made out regarding the internal anatomy of this abnormal limb either from preparations cleared and stained or from sections; but it was evident that the muscles in the propo-

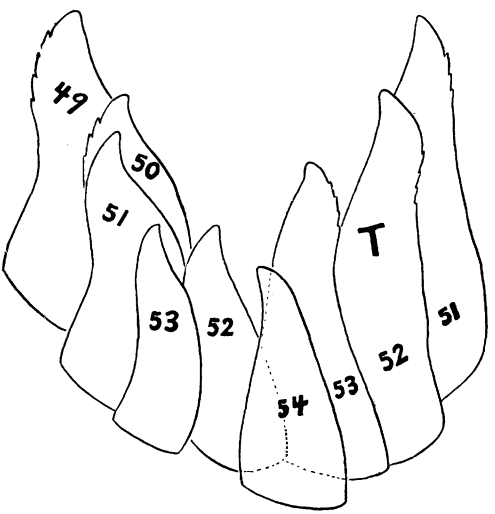

FIG. 5. Camera sketch, 2-D, of a posterior view of the plates at the angle between the two prongs.

dite were not arranged as in a normal propodite. At the distal end there were two muscle masses that seemed to connect with opposite edges of the articular end of the pronged structure. These would probably move this structure up and down in the plane of the claw. The usual muscles of abduction and adduction seemed to be developed, but attached to the dactyl in an abnormal way in connection with the above extra muscles and with abnormal widening of the distal part of the propodite.

The gist of the above description is that this abnormality is a case in which the propodite is to some extent double and bears a

normal claw as well as a pronged structure that simulates a claw even in details and was probably movable after the manner of a dactyl. This pronged structure is remarkable for its symmetry.

Comparing this with other described cases we find in the first place that it is unusual in being upon a walking leg. Of the thirty-one cases of abnormal appendages quoted by Bateson,[1] two are of antennæ, four are of non-chelate legs, and all the rest of chelæ except one, which is of a chelate walking leg.

Of the eleven additional cases given by Herrick[2] only two are of walking legs. However, this relative infrequency of described abnormalities in walking legs may be due, in part, to the greater ease with which other cases are collected or noted.

In the second place, it is unusual in being a monstrosity of the propodite. Bateson found the greater number of cases of repetition of parts, in the Crustacea, are repetitions of extra dactyls upon a normal dactylopodite (some fifty cases), and that next in frequency are the cases of extra index upon a normal index (some fifteen cases).

In the third place it seems to fall into none of the four categories established by Bateson, but rather to be like the exceptions, of which he found only two.

It has, however, resemblance to the case 815 of Bateson and more to the case shown in Fig. 195 of Herrick and still more to the case shown in Fig. 2 of Faxon,[3] which was described as follows: "This leg is provided with two chelæ. One of them has the ordinary form and structure, but is bent at a strong angle with the long axis of the leg. The second appears to have been budded off from an amputated surface of the propodite. It consists of two fingers which have the form of the normal dactylus and index, but neither is articulated with the other at the base. The two fingers together seem to be morphologically equivalent to a single segment, and represent a two-branched supernumerary dactylus."

Though the pronged structure we have described is markedly like a claw in its symmetry yet any tentative attempt to interpret

[1] Bateson, "Materials for the Study of Variation," 1894.

[2] Herrick, "The American Lobster," *Bull. U. S. F. C.*, 1895.

[3] Faxon, "On Some Crustacean Deformities," *Bull. M. C. Z.*, VIII., 1880.

it morphologically would seem to meet with more difficulty in assuming it to represent a claw than in assuming it to represent two fused dactyls or a branched dactyl. Were it a claw with fused articulation of dactyl and index we would have a limb so doubled distally as to have an extra segment and a lack of coincidence between the two series of segments. A propodite would spring from propodite instead of from a carpodite; and if we bear in mind the partial double appearance of the propodite and regard it as a fusion we would have a carpodite and a propodite springing from a carpodite, and so on.

Bateson's thorough study led to the conclusion that almost all cases could be interpreted as repetitions of claws in which there was more or less suppression of index or of carpus. The pronged structure would then be regarded as two party fused dactyls placed face to face and we would expect to find some representative of the two indices. On the line of imagined fusion there is a slight eversion of membrane where the pronged structure articulates with the propodite, but there is no reason for regarding this as of any morphological significance.

In the case described by Faxon, as quoted above, Bateson thought he had found a representative of the required indices in a small protuberance shown in Faxon's Fig. 2; this however was an error for I am informed by Faxon that "the artist unfortunately represented a protuberance which does not exist."

There are thus two cases in which pronged structures have nothing with them to countenance the idea that they represent double dactyls with even traces of double indices. Moreover, it will be seen from the above Fig. 2 that the prong nearer to the dactyl is not a mirror image of that dactyl but that it represents the index and likewise the other prong is not a mirror image of the index but represents the dactyl; this is true since all have their serrations nearer to the posterior face than to the anterior face. There is thus a departure from Bateson's rule of symmetry and we have to deal with a very unusual abnormality that is not interpretable in the same way as most of those hitherto known.

But any morphological interpretation seems somewhat premature and unsatisfactory in the lack of more knowledge of the

mode of formation of such structures. The appearance of the limb suggests a new growth following some injury in which the material for claw making was partly severed and displaced. This might happen, we can suppose, not only in the egg and in the young, but in the adult, especially at the periods of shedding when the interior of the claw is soft and the blood peculiar. That limbs may regenerate from a peripheral wound was shown by Herrick for the tips of the claws and by Morgan[1] for large parts of the limb. Possibly then such a monstrosity as this might arise in regeneration following an injury to the propodite.

An attempt to get experimental evidence resulted in failure, but this is what would be expected from the rarity of such monstrosities and from the difficulties in keeping the material long enough. In that attempt 103 mature *Cambarus affinis* were operated on in February. In each a deep cut was made in the carpodite of each chelate walking leg at a point corresponding to the pronged structure in this abnormal limb. In ten days many had healed, some could again use the dactyl and some had dropped the parts peripheral to the cut. Subsequently a piece was removed where the cut had been made in order to prevent such rapid healing. The breeding season then came on and after some months all the specimens had died without shedding and no new formations were found.

[1] Morgan, "Regeneration of the Appendages of the Hermit Crab and Crayfish," *Anat. Anz.*, XX., 1902.